

## Role of Unenhanced Multi-Detector Computed Tomography in Detection of Urinary Calculi Incomparison with Ultrasonography

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In the past few years, advancements in computed tomography (CT) technology have changed the trend of imaging techniques used in the evaluation of the urinary system. However, the accuracy is main concern for detecting urinary calculi. To compare unenhanced multi-detector computed tomography (MDCT) with ultrasonography (USG) for accurate diagnosis of urinary calculi. This cross-sectional study was conducted from June 2018 to May 2019 by involving 80 non-consecutive patients, who underwent unenhanced MDCT and USG for the diagnosis of urinary calculi. Diagnostic accuracy of MDCT and USG were measured by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). SPSS software Ver. 21.0 was used to perform statistical analysis. In the present study male to female ratio was 3.2:1 and the mean age was  $37.1 \pm 16.01$  years and  $41.2 \pm 14.16$  years, respectively. Flank pain was the commonest complaint recorded in 81.25% of patients. In both modalities, renal calculi were detected in 90% of the patients and in majority of patients (21.25%), stones were found in vesicoureteric junction and in 16.25% it was found upper junction of the ureter. Further, in most of the patient's calculi were detected bilaterally (41.25%), while in 31.25% and 27.5% patients, calculi were detected in left and right ureter, respectively. The sensitivity and specificity of MDCT in diagnosing ureteric calculi was 100% and 57.14%, respectively. The sensitivity of USG was 8.33% with 100% specificity. Hence, MDCT showed more sensitivity than USG in diagnosing urinary calculi. MDCT helps in accurate diagnosis of urinary calculi compared to USG.

**Keywords:** Flank pain, Urinary Calculi, Ureteral Calculi, Tomography, Ultrasonography.

Urinary calculi are solid deposits found in the urinary tract from minerals dissolved in the urine.<sup>1</sup> Calculi located in the kidneys, ureters, urinary bladder or urethra and are one of the major diseases that have affected people since ancient times.<sup>2</sup> The prevalence of urinary tract calculi is found to be greater in males (15%) than in females (8%) with a global annual incidence of 131 per 100,000.<sup>3,4</sup> Longstanding kidney stones

may cause obstruction and infection, which can ultimately lead to renal failure.<sup>5</sup> Hence, early accurate diagnosis of urolithiasis with appropriate treatment is pivotal for preventing complications and renal failure.<sup>6</sup>

In the last few years, several imaging techniques, particularly, X-Rays, USG, Intravenous Pyelography (IVP), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) were

used to diagnose urinary calculi in the renal tract. The most recent breakthrough in renal calculi imaging is an emergence of unenhanced multi-detector computed tomography (MDCT) and its use in ureteral and renal stone detection.<sup>7</sup> MDCT is the method of choice in assessment of urinary calculi due to its shorter examination time, safety and accuracy.<sup>8</sup> Patients with acute flank pain are typically diagnosed using intravenous urography (IVU) as the standard screening tool for identifying urinary calculi. However, intravenous contrast medium is required in IVU which is associated with potential risks.<sup>9</sup> Such concerns have led to the use of other methods such as the combination of plain abdominal X-ray and Ultrasonography (USG) and more recently MDCT.

MDCT produces thin collimated data of the urinary tract in a single breath hold and generates higher spatial resolution compared to single detector CT.<sup>10</sup> The capacity to provide reconstructions in the coronal, sagittal and oblique planes make it accurate in localization of calculi and different pathologies of the urinary tract. It provides accurate anatomical details of vital structures, providing valuable data for management decisions.<sup>11</sup>

From past three decades, USG is widely used for detecting urinary calculi, as it is non-invasive, and cheap method and it is the modality of choice for calculi detection under circumstances such as pregnancy and paediatric age group patients and it can detect stones located in pyeloureteric and vesicoureteric junctions (VUJ); however, it has limited diagnostic value in assessing urinary calculi, as it does not detect stones that are <5 mm in diameter, which may remain unrecognised due to a partial volume effect or the absence of posterior shadowing.<sup>12</sup> The detection of ureteral stones in mid ureter is not easily identified by USG, particularly in bowel interposition or in obese patients. Hence, the present study was undertaken to assess the accuracy of MDCT in comparison with USG for accurate diagnosis of urinary calculi.

## METHODOLOGY

### Study design

This cross-sectional study was conducted in the Department of Radiodiagnosis in a private hospital from June 2018 to May 2019 at Karad,

Maharashtra. Ethical approval from the institutional ethical committee and the informed consent from all patients was obtained prior to the initiation of the study. At 95% confidence interval and 80% statistical power, the sample size required was found to be minimum of 21 patients, to fulfil the primary objective. During the study period, 80 cases were diagnosed in the Radiology department and were included in the study to improve statistical reliability.

A total of 80 non-consecutive patients belonging to all ages and both sexes admitted into the various clinical departments who had presented with suspected urolithiasis by clinical signs and symptoms (flank pain and hematuria), who underwent unenhanced MDCT and USG for the diagnosis of urinary calculi, were considered for the study. Post-operative cases, extra renal masses invading the kidney and pregnant woman were excluded from this study.

### Data collection

A structured proforma was used to collect the demographic data such as age, gender, past history and complaints on admission. The findings of MDCT and USG such as location, site and other findings were also recorded.

### Procedure

In this study, the unenhanced MDCT imaging was performed using CT machine Siemens Emotion system 16 slice MDCT and the ultrasonogram was performed with Ultrasonography Siemens Acuson x 300.3.5 Mhz frequency Transducer.

During scanning procedure, patients were asked to drink one to one and half litres of water one hour prior to the scan so that their urinary bladder would be full at the time of the scan. The topogram or scout radiograph was obtained at 120kv and 40mAs with a collimation of 1 mm. The field of view of unenhanced computerized tomography was then plotted from the level of diaphragm to the base of the urinary bladder i.e., at the level of the pubic symphysis. The scan was carried out at 120kv and 130mAs with a slice thickness of 5.0mm at the collimation of 2.5 mm. No oral or intravenous contrast was administered during the study. The entire scan took a total of 10 to 15 seconds and was carried out in a single breath hold. The images are later reformatted at the thickness of 1.5 mm,

to facilitate detection of small calculi, which were invariably undetected by another imaging modality. Further these patients were subjected to USG abdomen examination.

For MDCT procedure, patients were placed in a supine position and in a single breath hold, scanning from the level of suprarenal glands to the infravesical level was performed. All patients were nil by mouth to avoid bowel gas artifacts.

#### Statistical analysis

Data were coded and tabulated on Microsoft Office Excel Spreadsheet and analysis were done using SPSS version 21. Diagnostic accuracy of USG was measured by calculating sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV). The correlation of the MDCT and USG diagnosis was identified using Cohen's kappa coefficient ( $\hat{\kappa}$ ). A p-value of  $<0.05$  was considered statistically significant.

**Table 1.** Clinical signs and symptoms

Complaints	Number	Percentage
Flank pain	65	81.25
Backache	41	51.25
Burning micturition	31	38.75
Headache	26	32.50
Hematuria	23	28.75
Fever	8	10.00

**Table 3.** Distribution of diagnosis based on MDCT and USG findings

MDCT Findings <sup>a</sup>	USG Findings								Total
	a	b	c	d	e	f	g	h	
a	5	0	0	0	0	0	0	0	5
b	2	1	0	0	0	0	0	0	3
c	0	0	13	0	0	0	0	0	13
d	0	0	0	14	0	0	0	0	14
e	0	0	0	0	9	0	0	0	9
f	0	0	11	0	0	0	0	0	11
g	0	0	10	0	0	0	3	0	13
h	0	0	12	0	0	0	0	0	12
Total	7	1	46	14	9	0	3	0	80

MDCT: Multi-detector Computed Tomography; USG: Ultrasonography; a: Vesical calculus; b: Hydronephrosis due to vesicoureteric junction calculus; c: Renal calculus; d: Vesicoureteric junction and renal calculus with hydronephrosis and hydroureter; e: Pelviureteric junction and renal calculus with hydronephrosis and hydroureter; f: Renal and mid ureteric calculus with hydronephrosis and hydroureter; g: Renal and upper ureteric calculus with hydronephrosis and hydroureter; h: Renal and lower ureteric calculus with hydronephrosis and hydroureter; a: Cohen's kappa coefficient

## RESULTS

Among the 80 patients enrolled in the study, 76.25% were males and 23.75% were females with mean age of  $37.1 \pm 16.01$  years and  $41.2 \pm 14.16$  years respectively. The patients presented with clinical signs and symptoms are given in the Table 1. The most common symptoms were observed to be flank pain (81.25%) and backache (51.25%) in most patients.

Both MDCT and USG scans identified renal stones in most patients (90%). With respect to the location of the calculus in ureter, in both modalities in majority of patient's (21.5%) calculi were found in VUJ followed by calculi in upper, mid and lower ureter. Further, in most of the

**Table 2.** MDCT and USG scan findings-Location

Location	MDCT (n=80) (%)	USG (n=80) (%)
Renal	72 (90)	72 (90)
Pelviureteric junction	9 (11.25)	10 (12.5)
Upper ureter	13 (16.25)	3 (3.75)
Mid ureter	11 (13.75)	0
Lower ureter	12 (15)	0
VUJ	17 (21.25)	17 (21.25)
Vesical	5 (6.25)	5 (6.25)

VUJ: Vesicoureteric Junction; MDCT: Multi-detector Computed Tomography; USG: Ultrasonography

patients, stones were detected bilaterally (41.25%), while in 31.25% calculus were detected in left side and in 27.5% of the patients calculus were detected in right side ureter. In MDCT scanning, presence of hydronephrosis was noted in 67.5% of patients and hydroureter in 65% of the patients. However, there was one case of perinephric fat stranding found in the MDCT scan (Table 2).

Further, the ultrasound findings revealed hydronephrosis in 72.5% of patients and hydroureter in 72.5% of patients. However, 11 (13.75%) cases of renal mid ureteric calculus with hydronephrosis and hydroureter, 13 (16.25%) cases of renal, upper ureteric calculus with hydronephrosis and hydroureter and 12 (15%) cases of renal and lower ureteric calculus with hydronephrosis and hydroureter could not be diagnosed on ultrasound and only renal calculus was seen on USG (Table 2).

There are eight diagnosis that are mentioned below. The numbers in the bold are

the diagnoses identified and confirmed by the MDCT and USG scan. USG was unable to identify the calculi in upper, mid and lower ureter with hydronephrosis and hydroureter (diagnosis “f”, “g”, “h”) and detected only renal calculi (diagnosis “c”). Whereas, MDCT could accurately locate the calculi in ureter. The correlation of the MDCT and USG diagnosis was using Cohen’s kappa coefficient ( $\hat{\epsilon}$ ). The degree of agreement between MDCT and USG was determined using Cohen’s kappa coefficient test. The kappa value was 0.52 (95 % CI) which indicates that there was good agreement between MDCT and USG findings; values between 0.40 and 0.75 indicate fair to good agreement. MDCT findings were found to be reliable in detecting urinary calculi and well matched with the USG.

There were 45 cases of same disease identified by both MDCT and USG scans and 35 cases of different diseases detected by the two scans. However, there was no statistical

**Table 4.** Accuracy of USG in comparison to MDCT for the diagnosis of ureteric calculi

Variables		MDCT		Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
		Positive	Negative				
USG	Positive	3	0	8.33	100	100	57.14
	Negative	33	44				

MDCT: Multi-detector Computed Tomography; USG: Ultrasonography; PPV: Positive predictive value; NPV: Negative predictive value



**Fig. 1.** Comparison of Ultrasonography and multi-detector computed tomography techniques

significance between the detection of disease and the findings of MDCT and USG scans ( $P=0.2684$ ).

By taking the diagnosis of ureteric calculi, the sensitivity and specificity of USG in comparison to MDCT was found to be low (Table 4).

## DISCUSSION

Radiological diagnostic tools play an important role in the differential diagnosis of flank pain and renal calcifications. There is a need for a highly sensitive and non-nephrotoxic means of instantly identifying calculi. USG is inexpensive, does not expose patients to ionizing radiation and can be performed at patient's bedside. However, it has highly variable sensitivity for detecting urinary calculi as reported by previous literature.<sup>13-15</sup> Hence, the present study was undertaken to assess the accuracy of MDCT in comparison with USG for accurate diagnosis of urinary calculi.

In the present study most patients were in their 30s and 40s, this supports the observations reported in previous reports that urinary calculi are most common in middle-aged people with a peak onset in the fourth decade of life.<sup>16</sup> On analysing the distribution of gender of the patients, it was observed that there was male predominance over female. This is consistent with previous literature reporting urinary calculi are more common in men.<sup>3,4,17</sup> In this study, flank pain was the most common complaint from majority of the patients, as flank pain is the primary sign of ureteric stone.<sup>18</sup>

In the current study, USG was not sensitive in detecting ureteric calculi compared to MDCT. Of the 36 cases with ureteric calculi, 3 cases were seen on USG. Unlike MDCT, USG could not detect the calculi in upper, mid and lower ureter with hydronephrosis and hydroureter and could identify only renal calculi. The sensitivity of USG found in this study was substantially low compared to other studies such as Ather *et al.* reported 81% and Passerotti *et al.* reported 76%.<sup>19,20</sup> The poor sensitivity and inaccuracy of USG could be due to lack of acoustic shadowing of ureteric calculi, which could have missed the detection of calculi in ureters. Other factors like selection of the focal length or transducer power could influence the accuracy of USG.<sup>21</sup> The sensitivity value of USG reported in the previous studies show a varying

range of 12% to 93% sensitivity of detecting ureteric calculi.<sup>13-15</sup> Fowler *et al.* revealed that USG is a poor diagnostic tool for identifying stones smaller than 4.0mm.<sup>22</sup>

Using the Cohen's kappa coefficient test, we found good agreement between the findings of MDCT and USG. This is in agreement with Ulasan *et al.* who reported a kappa value of 0.590.<sup>23</sup> The diagnostic accuracy of MDCT is said to be 99% of stones, including the radiolucent stones on plain film radiography can be detected.<sup>24</sup> The detection of urinary calculi by MDCT was found to be more effective than USG. Although, USG is not accurate compared to MDCT, it is readily available, non-invasive, safe and effective when MDCT scan is not available or cannot be performed. Overall, the present study showed that MDCT is more accurate in comparison with ultrasonography for the diagnosis of urinary calculi.

The limitation in the study was that time interval between USG and MDCT scans were not specified. This could affect the accuracy of the scan as the calculi might have moved or changed in size during the time interval. The chemical composition of the calculi was not considered in the study.

## CONCLUSION

The efficiency of MDCT for detection of urinary calculi is greater than USG. Further studies are needed for comparison of the diagnostic accuracy of MDCT in cases of urinary calculi".

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